FAO Fish.Rep.(71)vol.2:149-56 (1971)

4.18

SHRIMP RESOURCES OF THE CARIBBEAN SEA AND ADJACENT REGIONS[1/]

by

MILTON J. LINDNER
Bureau of Commercial Fisheries Biological Laborat
Galveston, Texas

CONTENTS

1 INTRODUCTION

Because assessments of renewable resources such as shrimp present several difficulties, it may be well to begin by specifying the precepts followed in this paper.

The area considered extends from North Carolina, U.S.A., through the Gulf of Mexico and the Caribbean Sea - specifically, the western Atlantic between Cape Hatteras, North Carolina, and the delta of the Orinoco River, Venezuela (here termed the Carolina-Venezuela region).

Shrimp catches and landings, unless otherwise noted, are reported in live weight of shrimp (heads on), in metric tons. In all countries except the United States and Mexico, landings reported as headless shrimp were multiplied by a factor of 1.68 to convert to live weight. Conversion factors used for Mexican landings were given by Lindner (1957), and those for U.S. landings appear in various statistical publications of the Bureau of Commercial Fisheries, Fish and Wildlife Service.

Where the fisheries appear to be stabilized, averages of the landings over a period of years were used so that undue emphasis was not given to unusual conditions; elsewhere, the latest data available were used. For some countries, particularly Colombia, production data are not recent.

Catches made by U.S. vessels off Mexico, Honduras, and Nicaragua were included in the landings of those countries to improve estimates of the shrimp stocks in those areas.

No projections were made for increased production from shrimp mariculture. Although shrimp culture has great future promise (Lindner and Cook, 1968), it is still in the experimental stage, and its feasibility for the region has not been proven.

Because no reliable data are available on the species composition of landings (except in the U.S.A. I grouped all species by country. These data on current landings and estimates of maximum yields are presented in Table I.

Only the species that normally spawn in waters of relatively high salinity are considered. Shrimp which are not now of some commercial importance or which are not likely to become of commercial importance in the foreseeable future are not included. Neither are the species of small size included (such as those of the genera Parapenaeus, Penaeopsis, and Trachypeneus) that may be taken and utilized incidentally in present commercial operations.

1/ Contribution No. 284 from the Bureau of Commercial Fisheries Biological Laboratory, Galveston, Texas 77550

4.18

TABLE I

Estimated current and potential production (metric tons, heads on) of shrimp from Cape Hatteras, North Carolina, U.S.A., to the Orinoco Delta, Venezuela

Country or area	Current production	Potential production
U.S.A.	78 700[1]	102 000–127 000[2]
Mexico	30 900[3]	33 000
British Honduras	200[4]	400
Guatemala	[5]	200[6]
Honduras	2 100[7]	3 000
Nicaragua	2 100[8]	4 000
Costa Rica	[5]	[9]
Panama	[5]	[9]
Colombia	400[10]	2 000
Venezuela	7 800[11]	11 000
Bahama Islands, Greater and Lesser Antilles, except Cuba	1 000[12]	2 000
Cuba	2 000[13]	2 500[13]
Total	125 200	160 100–185 100

[1] Based on 10-yr average, 1958-67

[2] Estimates include production gains of 15 000 to 40 000 t from future management programmes. This is the only country for which such estimates have been included.

[3] Based on 9-yr average, 1958-66. Includes landings of U.S. vessels whose catches were made off the coast of Mexico. Species caught by these vessels are Penaeus d. duorarum, P. a. aztecus, P. brasiliensis, and P. setiferus. Cuban landings from off Mexico are not available.

[4] Based on preliminary records of 1967 exports of 173 tons.

[5] Insignificant.

[6] Based on 140 t landed in 1959 (Croker, 1967).

[7] Estimate based on U.S. import records and landings of U.S. vessels whose catches were reported as made off Honduras in 1965.

[8] Based on local landings (Robert Ellis, personal communication) and landings by U.S. vessels whose catches were reported as made off Nicaragua in 1966.

[9] Insignificant. Based on recent exploratory fishing surveys (Robert Ellis, personal communication).

[10] Estimate by Lindner (1957).

[11] From 6-yr records of landings in 1962-67. A sizeable quantity of Venezuelan landings is heads on, but because no reliable estimates are available, all landings were considered heads off.

[12] All of the countries and entities throughout the Bahama Islands and the Greater and Lesser Antilles, except Cuba, were grouped. Although practically all have localized shrimp fisheries, they are not large nor are they likely to become so. Because available landing data are scanty, estimated and potential production are approximations only.

[13] Personal communication (J.R. Gonzales Cardulis).

2 SPECIES AND RANGES OF COMMERCIALLY IMPORTANT SHRIMP IN THE CAROLINA-VENEZUELA REGION

Estimates of maximum production were restricted to the 10 species and subspecies whose ranges and known concentration localities follow.

2.1 Shallow-water forms of the genus Penaeus.[2/]

2.1.1 Penaeus setiferus (Linnaeus) - the white shrimp - has been reported from Fire Island, New York, to about Punta Chapote, Campeche, Mexico (Lindner and Cook, 1970). Three distinct locations where this species is fished intensively are: (a) from Cape Hatteras, North Carolina, to Fort Pierce, Florida, with the centre of abundance off Georgia and northeastern Florida; (b) from Apalachicola Bay, Florida, to northeastern Mexico, with the centre of abundance in Louisiana; and (c) from about Tupilco, Tabasco, Mexico, to Campeche, Mexico, with the centre of abundance near Isla del Carmen, Campeche, Mexico.

2.1.2 P. schmitti Burkenroad - the camarón blanco - extends throughout the Antilles and from Belize, British Honduras, to Laguna, Brazil (Pérez Farfante, 1970). Concentrations are scattered more widely than those of P. setiferus. P. schmitti occurs in fishable concentrations throughout the region in Cuba, Guatemala, Honduras, Nicaragua, Colombia, Venezuela, and Trinidad (Lindner, 1957; U.S. Fish and Wildlife Service, 1958; Pérez Farfante, 1970). These stocks do not seem to be especially large except in Cuba, Honduras, Nicaragua and Venezuela. In none of these localities, however, do stocks appear to be comparable in numbers to the stock of P. setiferus off Louisiana.

2.1.3 P. aztecus aztecus Ives - the brown shrimp - ranges from Martha's Vineyard, Massachusetts, south through the Gulf of Mexico to about Campeche, Campeche, Mexico (Pérez Farfante, 1969). There are four principal concentrations: (a) along the Carolinas; (b) between the State of Mississippi and northeastern Mexico; (c) from north of Tampico to Veracruz, Mexico; and (d) along the coast of Tabasco and southwestern Campeche, Mexico. The area of greatest abundance is in the north central and northwestern Gulf of Mexico, namely, concentration (b) above (Cook and Lindner, 1970).

2.1.4 P. aztecus subtilis Pérez Farfante - the camarón marron - occurs throughout the Antilles and from Honduras to Cabo Frio, Brazil. It is not of great commercial importance in the Antilles and does not rank high in the commercial catches of Honduras and Nicaragua. It is, however, of some importance in Venezuela. Major stocks appear to be south of the region being considered here, along the coasts of Guyana, Surinam, French Guiana, and Brazil (Pérez Farfante, 1969).

2.1.5 P. duorarum duorarum Burkenroad - the pink shrimp - ranges from lower Chesapeake Bay, south through the Gulf of Mexico to Isla Mujeres, Quintana Roo, Mexico (Pérez Farfante, 1969). The two greatest concentrations are along the southwest coast of Florida and on the Campeche Banks off the state of Campeche, Mexico.

2.1.6 P. d. notialis Pérez Farfante - the candied or caramel shrimp - is known from Cuba to the Virgin Islands and from Bahía de la Ascensción, Quintana Roo, Mexico, to Cabo Frio, Brazil. It also ranges from Cabo Blanco to Angola in the eastern Atlantic. It is concentrated in Cuba, British Honduras, Honduras, Nicaragua, and the Gulf of Venezuela (Pérez Farfante, 1969).

2.1.7 P. brasiliensis Latreille - the spotted shrimp - ranges from Cape Hatteras to the Tortugas Islands; from the Bermuda Islands throughout the Antilles; and from Cabo Catoche, Mexico, to Lagoa dos Patos, Brazil (Pérez Farfante, 1969). Small quantities are taken for bait in Biscayne Bay, Florida, but the species is not of great commercial importance in the region except from Cabo Catoche to Isla Mujeres, Mexico, the eastern coast of Honduras, the coast of Nicaragua, and to some extent in Colombia and Venezuela. The largest stocks apparently are south of the region considered here.

2.2 Shallow-water forms of the genera Xiphopeneus and Sicyonia

2.2.1 Xiphopeneus kroyeri (Heller) - the seabob - ranges from Cape Hatteras, North Carolina, to southern Brazil (Williams, 1965). Commercial concentrations are in the northern Gulf of Mexico (particularly west of the mouth of the Mississippi River), Nicaragua, eastern Venezuela, and Trinidad. The largest stocks are south of the region considered here.

[2/] Species of this genus produce practically all of the commercial catch in the region under consideration. I have followed Pérez Farfante (1967, 1969 and 1970) for the taxonomy and ranges of shrimp of the genus Penaeus, and am indebted to her for permitting me to use her material on the distribution of Penaeus of the western Atlantic.

4.18

2.2.2 Sicyonia brevirostris Stimpson - the rock shrimp - ranges from Norfolk, Virginia, through the Gulf of Mexico to Yucatan, Mexico, and throughout the Bahama Islands and Cuba (Williams, 1965). Known concentrations occur: (a) from about Charleston, South Carolina, to New Smyrna, Florida (Anderson, 1956); (b) in the northwestern Gulf of Mexico (Brusher and Renfro, MS); and (c) in the Gulf of Campeche (Hildebrand, 1954).

2.3 The deep-water form of the genus Hymenopenaeus[3/]

2.3.1 Hymenopenaeus robustus Smith - the royal red shrimp - ranges throughout the entire region (Thompson, 1967 and Roe, 1969, cited numerous references on the exploratory work of S. Springer, H.R. Bullis, and others which show the distribution of this species). Fishable concentrations are known to exist only in three locations, all of which are along the coast of the U.S.A: (a) off the east coast of Florida between latitudes 27°31' and 31°00'N; (b) along the Florida Straits between longitudes 82°20' and 84°00'W; and (c) southeast of the Mississippi River Delta between longitudes 87°15' and 91°00'W. These grounds are named, respectively, St. Augustine, Dry Tortugas, and Mississippi Delta (Roe, 1969).

3 PROBLEMS IN ESTIMATING POTENTIAL HARVEST

At this point it may be fruitful to discuss the methods for estimating potential harvest for regions about which we have only limited information. Bear in mind though that what we are striving for is a reliable estimate of the fishable magnitude of a stock of shrimp. We need to know how best to estimate the maximum sustained number of tons that can be harvested each year from a stock. The most precise measures of production are those based on growth, mortality, and recruitment rates from heavily fished stocks. These rates, however, are difficult to determine and, indeed, may be impossible to obtain even though the species is heavily fished. It is clear, therefore, that in most fisheries we are obliged to use as the best estimate some amount that is less accurate than might be desired. The degree of accuracy, of course, depends on the method used in making the estimate.

For a region that has not been fished, we might base estimates (more aptly, guesses) on the range of species or on the size of the trawlable fishing grounds. Projections of the fishable magnitude of stocks of shrimp on these bases are subject to such wide error, however, that they are of little use because shrimp do not distribute themselves uniformly over vast areas. Instead, they concentrate in certain localized areas where, presumably, temperature, substrata, and food are suitable. For most species, only fragmented bits of information are available on these subjects.

The situation would be considerably improved if, in addition to species range and trawlable area, we also had information from exploratory fishing. We would still, however, not be able to make reliable estimates of potential harvests. Estimates calculated from exploratory fishing alone approximate only the standing crop or, in other words, only the weight present at one time. An estimate of the standing crop may be highly deceiving if it is used to estimate the fishable magnitude of a stock.

An additional difficulty in establishing potential harvests from catches of exploratory vessels was pointed out by Stark and Slack-Smith (1968). They demonstrated that, when an exploratory vessel fished an area on a preselected grid of points and a commercial fisherman later fished this same area, but operated only in those places where organisms were most abundant, the catch rate of the fisherman was always higher than that of the exploratory vessel. This axiom is valid only under the conditions given by Stark and Slack-Smith. If, however, the exploratory vessel simulates commercial fishing only in the best locations, then its catch rate should be similar to that of an individual commercial fisherman who later fishes that area. Under this latter condition, however, the catch rate of the exploratory vessel can be expected to be considerably greater than that of any individual vessel within a large fleet fishing the same area at a later date. In fishing for shrimp of the genus Penaeus in the better portions of a newly discovered area, the catches of a single vessel must be extremely large to indicate the presence of a stock of sizeable magnitude. The point here is that the catch rate of a vessel is influenced by its competition.

About 10 years ago I wrote a brief note (Anonymous, 1959) that illustrates this point. This article described catches of Penaeus shrimp made by fishermen along the west coast of Mexico on virgin or nearly virgin grounds which later supported a substantial fishery.

3/ Hymenopenaeus robustus is the only species of deep-water shrimp considered. I am grateful to Harvey R. Bullis, Jr., for allowing me to study various papers (now in press) authored by him and members of his staff concerning some of the results of exploratory operations in the region.

Because the note has been repeatedly overlooked, and because I had to do considerable research to uncover the material, I propose to bring it to life again and quote a part of it here: "The Japanese fishing vessel MINATO MARU, in 21 consecutive days of fishing along the virgin coast of Sinaloa, Mexico, in May 1936, caught 92 074 lb (41.8 metric tons) of shrimp (headless). The average daily catch was 4 384 lb (1 989 kg) of tails. The MINATO MARU fished a V. D-type net with a mouth (not including wings) of 20 m (about 65.5 ft). This phenomenal catch when compared with current yields per boat helps to answer the question 'What is a good virgin shrimp fishing grounds?'

"Some 10 years later on these same grounds, when fishing intensity had increased considerably, but was still not extremely intense, a group of 8 small boats operating between August 1946 and May 1947, caught a daily average of more than 1 000 lb (454 kg) each of headless shrimp. These boats were between 28 and 38 ft (8.5 and 11.6 m) in length, with 40 to 55 hp gasoline engines, and hauled nets between 30 and 45 ft (9.1 and 13.7 m) along the lead line. They fished an average of 12 hours a day, returning to port each night."

Although there was not much more to the note than this, I thought the readers would infer its import. Obviously, they did not, so now I shall add two short paragraphs to emphasize what I intended the note to convey.

By 1956 the shrimp fleet on the west coast of Mexico had grown to about 500 boats. Fishing intensity had increased considerably and the Mazatlán, Sinaloa, fleet fished not only the coast of Sinaloa but also the coasts of Sonora, Nayarit, Baja California, Oaxaca, and Chiapas. The fishing season was 10 months or more - more, if one fished the Oaxaca-Chiapas grounds. Any owner of a modern boat in 1956 considered himself fortunate if his boat caught as much shrimp in 10 months as did the MINATO MARU during 21 days in 1936, and he would have been elated if the catch were equal to that of one of the small boats in 1946-47.

The MINATO MARU explored the virgin coast of Sinaloa and simulated commercial fishing. I do not know if the MINATO MARU fished 24 h a day, but assuming that it did, the hourly catch (headless) during the 21-day period was about 83 kg. Throughout the 10 month period in 1946-47, the catch rate of the eight small boats averaged about 38 kg each of headless shrimp per hour of trawling.

If you think you have discovered a large stock of Penaeus, please do not forget that the catch of the MINATO MARU amounted to about 2 metric tons of shrimp tails a day for 21 consecutive days. If you do forget, my present effort also will have been for naught.

I surely do not wish to leave the impression that I am opposed to exploratory fishing. I have merely pointed out some of the problems involved in the interpretation of data gathered solely from this type of research. In fact, I have used standing crop estimates in developing estimates of potential yield.

Obviously, however, more information than that provided by exploratory fishing is needed if good estimates of fishable stocks are desired. This additional information may be ecological, involving knowledge of the life history and the feeding and nursery areas of the species; it may be based on a comparison of the catch rates or landing data of the same or a similar species with those in another area where intensive fishing is in progress; or, as mentioned earlier, it may include the rates of growth, mortality, and recruitment.

The use of ecological data or catch data, or preferably a combination of them, usually does not require the sophisticated methods involved in arriving at rates, and frequently the combination can give fairly reliable estimates. It seems, therefore, that we need to start accumulating data on the first two subjects before we can project more accurately than now the fishable magnitudes of shrimp stocks in areas that are not heavily fished. The cooperative effort, which includes statistical, ecological, and life history studies, undertaken by the Governments bordering on the Caribbean Sea and FAO is an excellent approach toward this end.

You will notice that I have restricted my discussion to the genus Penaeus. This is because we know a good deal about its ability to withstand fishing pressure, its stock production, and the catches that have been made by exploratory fishing. Shrimp of this genus are relatively short-lived, rapidly growing, and highly fecund, with ability to withstand tremendous fishing mortalities. Probably Xiphopenaeus should also be included. When we go beyond these two genera in the Carolina-Venezuela region, however, and particularly when we begin to deal with deep-water species, we are on dangerous ground. Little or no information is available upon which to make comparisons between standing crops and crop production for deep water penaeids.

4.18

The preceding information and the great amount of exploratory fishing undertaken for shrimp in recent years by Governmental agencies and by private industry make it highly probable that no large stocks of Penaeus shrimp remain undiscovered in the region under consideration.

If we were to take a close look at the stocks of Penaeus in the Carolina-Venezuela region, I suspect we would find that, under present fishing conditions, practically all are being fished at or near their maximum productive levels. I strongly suspect, but cannot establish yet, that P. setiferus in the northern Gulf of Mexico has been overfished since about the mid-1940's. Overfishing of this species also may be occurring in other areas, and possibly P. schmitti is being overfished in the Gulf of Venezuela. These two shallow-water species of Penaeus rarely range into depths greater than 40 m, and in some locations the entire stocks, after recruitment, are subject to intensive fishing for the remainder of their lives.

The largest and presumably more fecund specimens of P. setiferus in the northern Gulf of Mexico inhabit the deeper portions of the range. When these shrimp, after undergoing extremely intensive fishing in the estuaries and near-shore coastal waters, move into depths beyond 18 m, they encounter the intensive fishery for P. a. aztecus, which extends to about 80 metres. As a consequence, adults of P. setiferus in the northern Gulf of Mexico are subject to intensive fishing throughout their bathymetric range. They have no refuge areas for spawning reserves.

The distributions of the U.S. stocks of P. a. aztecus and P. d. duorarum in the Gulf of Mexico, in relation to the fisheries, are very different from that of P. setiferus in the northern Gulf. Large numbers of adult P. a. aztecus range into depths considerably greater than those frequented by most of the fishing fleet, and consequently, there still is a reserve spawning supply. P. d. duorarum not only moves into depths greater than those of the present fishery, but also large numbers of this species inhabit the region between the Sanibel and Tortugas fishing grounds. This region cannot be fished intensively because of corals and sponges; consequently, this species also has a spawning reserve.

Our present knowledge allows us only to speculate as to what would happen to these stocks of brown and pink shrimp if a gear were developed or if the economics of the fishery were such that these spawning reserves became heavily fished.

4 POTENTIAL INCREASES IN SHRIMP PRODUCTION

We have evidence that the production of Penaeus shrimp in waters of the United States could be increased appreciably, providing it were possible to reduce the number of small shrimp that are being taken. This evidence, although somewhat preliminary, is based on rates of growth and natural and fishing mortality derived from carefully controlled mark-recapture experiments. We estimate that the U.S.A. could increase its annual landings of Penaeus shrimp from its own waters by about 15 000 to 40 000 metric tons if fewer small shrimp were taken. These estimates, of course, are subject to revision as our research progresses.

I have no idea what comparable research on Penaeus in other areas of the Carolina-Venezuela region would reveal, but I suspect it would disclose that landings in some areas could be increased considerably. This assumption suggests that even with Penaeus we cannot now make reliable projections of maximum yields.

How one goes about reducing the capture of small shrimp is another story, not relevant here, because usually there are economic, sociological, legal, and political problems to be solved. Because these problems may be solved eventually, I included our estimates for increased landings in the U.S.A. in Table I. Similar estimates for other countries were not included because, as far as I know, none exist.

When we consider the other shallow-water forms, Xiphopeneus kroyeri and Sicyonia brevirostris are apparently the only two that have immediate potential for commercial expansion. These shrimp are smaller than Penaeus and are not now of great commercial interest. Because the demand for Xiphopeneus riveti from the Pacific coasts of Central America and northern South America is increasing, however, more use of Xiphopeneus from the western Atlantic can be expected. The three most likely areas for increased production of the seabob are in the Gulf of Mexico, Nicaragua, and near the mouths of the Orinoco River in eastern Venezuela.

Fisheries on the stocks of rock shrimp, Sicyonia brevirostris, are less likely to develop as soon as those for the seabob. The reasons are: (a) their flavour is different from that of the shallow-water commercial penaeids; (b) the shell is much harder and more difficult to peel than that of other shallow-water penaeids; and (c) the stocks probably are not large. Bullis, Carpenter, and Roithmayr (in press) estimated a standing crop of about 2 500 metric tons along the east coast of Florida, and there probably are comparable amounts in the northwestern Gulf of Mexico and on the Campeche grounds.

The deep-water shrimp extend over such vast regions that their stocks appear to be relatively large. These stocks, however, are not sufficiently concentrated to permit commercial fishing with known gear at this time except in a few locations. The only deep-water species that has been fished commercially in the Carolina-Venezuela region is the royal red shrimp (Hymenopenaeus robustus). This species has been fished sporadically on the three known grounds for a number of years, but more attention appears to have been paid to it in the past 6 years than previously.

Thompson (1967) cited the exceptional catch of about 77 metric tons (headless) of royal red shrimp by the commercial fishing vessel TERRY ANN on the St. Augustine grounds during the first 10 months of 1963. The only recent data I have available pertain to the Dry Tortugas grounds. In 1966, commercial fishermen caught about 11 metric tons (headless) in 890 hours of trawling on these grounds. The rate of catch was about 12 kg/hour. In 1967 on these same grounds, they caught about 14 t in 2 000 hours of trawling, which amounted to a rate of about 7 kg/hour. This drop in catch rate suggests a stock of small size, but the data are not adequate for such a conclusion.

Thompson (1967) mentioned the difficulties in fishing for royal red shrimp, but there also are some marketing problems. This species, like the rock shrimp, has a distinctive flavour and it must be boiled differently than Penaeus to give it proper texture. Bullis, Carpenter, and Roithmayr (in press) estimated the annual standing crop on the three known grounds to be about 700 metric tons.

Four other deep-water penaeids - Aristaeomorpha foliacea (Risso), Aristeus antennatus (Risso), Penaeopsis megalops (Smith), and Plesiopenaeus edwardsianus (Johnson) - and the pandalid, Plesionika edwardsii (Brandt), have been reported on numerous occasions throughout the region by Bullis and his co-workers. None of these except Penaeopsis megalops (which is small) was in concentrations sufficient to support a commercial fishery (Bullis, Carpenter, and Roithmayr, in press). These species have not been included in the estimates.

5 SUMMARY

Current landings for the western Atlantic Ocean between North Carolina, U.S.A., and the Orinoco River, Venezuela, are estimated at about 125 000 metric tons. Estimates of potential landings range from 160 000 to 185 000 tons. If 15 000 to 40 000 t from the U.S.A. that might eventually accrue by changing present management procedures are not included the potential production we can expect by increasing fishing in some localities and by fishing species not now utilized is about 145 000 t - or about 20 000 t more than are now being landed.

We can expect only about a 15 percent gain in landings by increasing fishing effort, and much of this gain is highly speculative. Improved management, however, can result in a gain in the U.S.A. alone of 15 000 to 40 000 tons. This represents an increase of between about 10 and 30 percent. The U.S. landings are about 60 percent of the total for the Carolina-Venezuela region. Since I do not know what improved management might accomplish in the remainder of the region, I have not taken it into account in estimating potentialllandings; the projections also do not include possible gains from shrimp mariculture.

4.18

6 REFERENCES

Anderson, W.W., January to April distribution of the common shrimp on the south Atlantic continental
1956 shelf. Spec.scient.Rep.U.S.Fish Wildl.Serv.(Fish.), (171):14 p.

Brusher, H.A. and W.C. Renfro, Notes on the distribution, size, and spawning of nine species of penaeid shrimp in the northwestern Gulf of Mexico (MS)

Bullis, H.R., Jr., J.S. Carpenter and C.M. Roithmayr, Latent resources for southeastern fisheries of
(in press) the United States. In U.S.Fish and Wildl.Serv.,(fish). vol.1.chapt.26

Cook, H.L. and M.J. Lindner, Synopsis of biological data on brown shrimp Penaeus aztecus aztecus Ives
1970 1891. FAO Fish.Rep., (57)vol.4:1471-97

Croker, R.S., The shrimp industry of Central America, the Caribbean Sea, and northern South America.
1967 Foreign Fish.Leafl.U.S.Fish Wildl.Serv., (74):127 p.

Hildebrand, H.H., A study of the fauna of the brown shrimp (Penaeus duorarum Ives) grounds in the
1954 Gulf of Mexico. Publs Inst.mar.Sci.Univ.Tex., 3:231-366

Lindner, M.J., Survey of shrimp fisheries of Central and South America. Spec.scient.Rep.U.S.Fish
1957 Wildl.Serv.(Fish.), (235):166 p.

Lindner, M.J. and H.L. Cook, Progress in shrimp mariculture in the United States. FAO Fish.Rep.,
1968 (71.1):153

_____, Synopsis of biological data on white shrimp Penaeus setiferus (Linnaeus) 1767. FAO Fish.
1970 Rep., (57) vol.4:1439-69

Pérez Farfante, I., A new species and two new subspecies of shrimp of the genus Penaeus from the
1967 western Atlantic. Proc.biol.Soc.Wash., 80(14):83-100

_____, Western Atlantic sh mp of the genus Penaeus. Fishery Bull.U.S.Fish Wildl.Serv., 67(3):
1969 461-591

_____, Sinópsis sobre la biología del camarón blanco Penaeus schmitti Burkenroad, 1936. FAO
1970 Fish.Rep., (57)vol.4:1417-38

Roe, R.B., The distribution of royal-red shrimp (Hymenopenaeus robustus Smith) on three potentially
1969 commercial grounds off the southeastern United States. Fishery Ind.Res., 5(4):161-74

Stark, A.E. and R.J. Slack-Smith, General remarks on the design, analysis and evaluation of fishery
1968 resource surveys. FAO Fish.Rep., (57)vol.2:549-58

Thompson, J.R., Development of a commercial fishery for the penaeid shrimp Hymenopenaeus robustus
1967 Smith on the continental slope of the southeastern United States. Symp.Ser.mar.biol.Ass. India, 2(4):1455-9

U.S.Fish and Wildlife Service, Bureau of Commercial Fisheries, Branch of Economics, Foreign shrimp
1958 fisheries other than Central and South America. Spec.scient.Rep.U.S.Fish Wildl.Serv.(Fish.), (254):71 p.

Williams, A.B., Marine decapod crustaceans of the Carolinas. Fishery Bull.U.S.Fish Wildl.Serv., (65):
1965 298 p.

Anon., (Lindner, M.J.), Shrimp stocks off west coast compared with 1936. Comml Fish.Rev., 21(5):67-8
1959